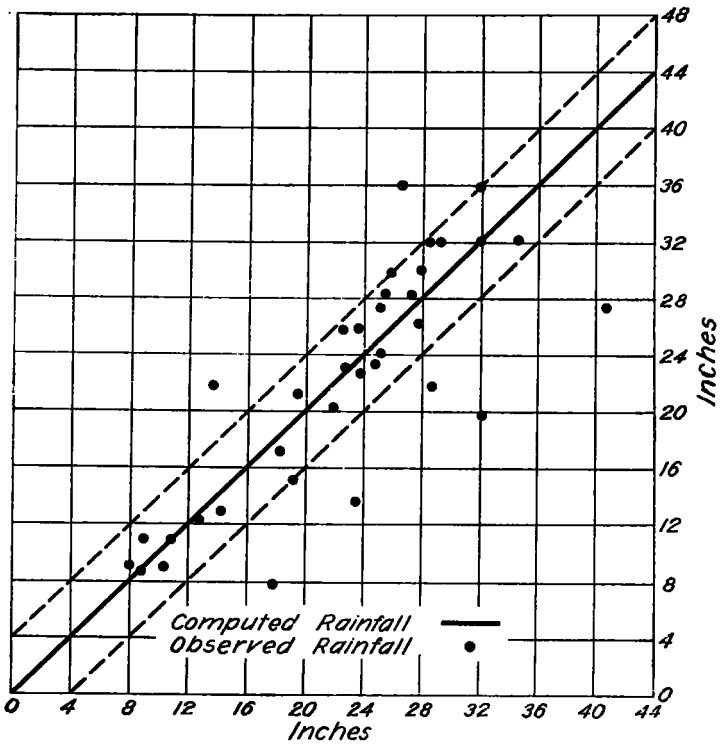

FIG. 9.—Relation of computed to observed rainfall, all groups

BIBLIOGRAPHY

1912. The distribution of ocean temperatures along the west coast of North America, deduced from Ekman's theory of the upwelling of cold water from the adjacent ocean depths. Intern. Rev. ges. Hydrobiol u. Hydrog., 5, 234–286, 21 figs. in text.

1914. Peculiarities of the California climate, explained on the basis of general principles of atmospheric and oceanic circulation. Mon. Weath. Rev., 42, 14–23, 13 figs. in text.

1916. Summary and interpretation of the hydrographic observations made by the Scripps Institution for Biological Research of the University of California, 1908–1915. Univ. Calif. Publ. Zool., 15, 255–356, pls. 1–38, figs. A–C in text.

1918. Oceanic circulation and its bearing upon attempts to make seasonal weather forecasts, a sketch of observational methods and explanations. Bull. of the Scripps Institution for Biological Research of the Univ. of Calif., No. 7, 20 pages.

1918. Ocean temperatures, their relation to solar radiation and oceanic circulation. Semicentennial Publications of the University of California, 1868–1918, 335–421, figs. 1–19 in text.

A STUDY OF SEASONAL FORECASTING FOR CALIFORNIA BASED ON AN ANALYSIS OF PAST RAINY SEASONS

By L. E. BLOCHMAN

[Berkeley, Calif.]

SYNOPSIS

A study in seasonal forecasting is here outlined on the theory that conditions are forming over the Pacific Ocean before the rainy season begins, and also during the opening months, that will, when interpreted, indicate the character of the ensuing rainfall season with a high average of probability.

I have investigated the last 40 seasons (ending 1924–25) for pressure, and for rainfall as far back as records are available. I have ascertained that when low-pressure areas enter directly the central to southern California coast in September or October, there is a ten-to-one probability that the ensuing season (for central and southern California) will be an average to wet one.

I have also collected data to show that in the seasons in which San Diego has above average summer rains (July, August, or September) the ensuing rainy season will likewise be average to wet, with a 90 per cent probability.

The forecast values of appreciable rains in November as far south as Santa Barbara is also considered.

The rainfall for the same seasons in northern, central, and southern California are sometimes proportionately alike while in other seasons they are radically different. Of the seasons in which there are no early movements of LOWS or no summer rains at San Diego, some are still average to wet ones, but all the dry or partly dry seasons follow such rainless summers.

The present status of seasonal forecasting.—The investigation of seasonal forecasting of rainfall for California has until recent years been handicapped by lack of sufficient data. Weather Bureau records for the continental area are abundant, but it is only since 1922 that we have been able to form much idea of conditions over the Pacific through radio reports. Thanks to the success of the San Francisco office of the Weather Bureau in enlisting the cooperation of steamship companies, data from the oceanic area are now being received which will enable us gradually to improve the basis of our attempts at seasonal forecasting for California. This is a subject which, owing to its economic importance, is well worth all the attention any investigator can give to it.

Though seasonal forecasting is a baffling subject, it is not hopeless. The Indian meteorologists have for many years studied the movements and intensities of the monsoons as affecting and forecasting the rainfall of India a few months in advance, and their efforts have met with considerable success. For southern California, McEwen has investigated the relation between the water temperatures off the coast in summer and the rainfall of the following rainy season. His method has so far produced very encouraging results. But we are still in the pioneer stage of long-range forecasting, and conclusions must be accepted tentatively and held open to revision as data accumulates.

Three divisions of the State for rainfall.—This State is so generally considered as northern and southern California that meteorologists have fallen into the same habit. I believe, however, that it is much more accurate to divide it into three sections, northern, central, and southern. Even this demarcation is somewhat vague; however, as nearly as seemed practicable, I have drawn the lines of division as follows: A line from northern Marin County to the city of Marysville would divide the northern from the central section, and a line from the coast at Monterey across to Merced would mark the division between central and southern California. Our main discussion will relate to the central and southern California sections. The dry region everywhere east of the Sierra is climatically always in a separate class.

In referring to rainy seasons they are always understood on the Pacific coast to begin with July 1 and to end with June 30. East of the Rockies the season agrees with the calendar year. As to the kinds of rainy seasons, I divide them into four types and consider that any further division would be impracticable. It becomes

necessary also to extend the range of the rainfalls which shall be considered as average for the season, and which should be limited on the one hand by rainier seasons and on the other by the drier. Expressed in percentages of the normal seasonal rainfall they are as follows:

WET seasons range upward from 120 per cent of normal.

AVERAGE seasons range from 80 to 120 per cent of normal.

MODERATELY DRY seasons range from 60 to 80 per cent of normal.

VERY DRY seasons range from 60 per cent of normal down.

Although the Weather Bureau classifies the depressions which enter the United States as North Pacific LOWS and South Pacific LOWS according to whether they come on shore north or south of latitude 40°, I have, for the purpose of this study, considered 43° as the dividing line, because the entrance of September LOWS north or south of this line seems so clearly related to the character of the ensuing rainy season in central and southern California.

The forecast value of September LOWS.—In some seasons in California rains begin in September; and while the September rainfall for central California averages only about 0.25 inch, in certain seasons it is much heavier. From the point of view of forecasting, however, it makes no difference as to the amount of the rainfall—its *source* is the factor for consideration. Prof. A. J. Henry has pointed out[1] that "Our precipitation in California is great or small according as to whether areas of low pressure enter the continent and move eastward in low or high latitudes."

It has been a moot question in California whether heavy September rains, being premature, were not indicative of an unfavorable ensuing rainy season. I therefore made a chart of the exact location where all of the September (and also October) LOWS entered the coast. I found very definite relationships between the point of entrance of the LOWS lower or higher on the coast, and the character of the ensuing rainfall season. It was not a casual matter, for instance, when a depression centered directly off the southern California coast. It meant that the HIGHS were not so intense as at the opening of other seasons or else that they were further back over the ocean. This allowed the LOWS not only to dominate the situation, but it seemed to be indicative of a condition for the coming season, namely an increased rainfall, or at least an average rainfall.

The approximate points of entrance of September LOWS since 1883 onto the Coast is shown in Table 1 together with the character of the subsequent rainfall season for central and southern California.

I summarize my investigation of September LOWS as follows:

1. Lows entering north of latitude 43° were followed by any of the several types of seasons, *but they preceded all the drier seasons.*

2. Lows entering south of latitude 43° were almost never followed by the very dry seasons; a very few were of the moderately dry type. September LOWS entering south of Cape Mendocino were almost invariably followed in southern California by normal or wet seasons.

[1] Henry, A. J., Seasonal forecasting of precipitation on the Pacific Coast, Mo. Wea. Rev., April 1921, p. 214.

TABLE 1.—*Character of the rainy season in central and southern California following the occurrence of* LOWS *on the Pacific Coast between Vancouver Island and Lower California in September*

	Latitudes at which LOWS entered the coast	LOWS occurred in September of the year	Character of the ensuing season in California	
			Central	Southern
North Pacific LOWS [3]	North of 45° N.	1884	Moderately dry.	Moderately dry.
		1885	Normal or above.	Normal or above.
		1889	Far above normal.	Far above normal.
		1891 (2)	Normal or above.	Moderately dry.
		1892	Normal or above.	Normal or above.
		1893 (2)	Normal or above.	Very dry.
		1894 (2)	Normal or above.	Normal or above.
		1897	Very dry.	Very dry.
		1899	Moderately dry.	Moderately dry.
		1902	Normal or above.	Normal or above.
		1904	Normal or above.	Normal or above.
		1905 (2)	Normal or above.	Normal or above.
		1907	Normal or above.	Normal or above.
		1912	Moderately dry.	Moderately dry.
		1913	Normal or above.	Normal or above.
		1914	Normal or above.	Normal or above.
		1920	Normal or above.	Moderately dry.
	41° to 45° N.	1883	Normal or above.	Normal or above.
		1889	Far above normal.	Far above normal.
		1895	Normal or above.	Moderately dry.
		1901	Normal or above.	Moderately dry.
		1903	Normal or above.	Mod. dry to very dry.
South Pacific LOWS [3]	Approximately 39° N.	1888	Normal or above.	Normal or above.
		1902	Normal or above.	Normal or above.
		1904	Normal or above.	Normal or above.
		1909	Normal or above.	Normal or above.
		[1] 1919	Moderately dry.	Moderately dry.
	Approximately 37° N.	1908	Normal or above.	Normal or above.
		1916	Moderately dry.	Normal or above.
	Approximately 35° N.	1887	Moderately dry.	Normal or above.
		[1] 1898	Moderately dry.	Very dry.
		1910	Normal or above.	Normal or above.
	Approximately 33° N.	1900	Normal or above.	Normal or above.
		[2] 1911	Very dry.	Normal to mod. dry.
		1918	Normal or above.	Normal to very dry.
		1921	Normal or above.	Normal or above.

[1] Westward extension of an interior LOW.
[2] Sonora type storm.
[3] U. S. Weather Bureau classification.

3. Two LOWS in the table show a westward spreading or extension in September, and were followed by the moderately dry type of season. The westerly extension of LOWS at this time of year is evidently not favorable to precipitation in central and southern California.

In September the North Pacific LOWS predominate, some of them entering well to the north of the area included in the United States Weather Bureau weather map, coming into the United States east of the Rockies in the usual course. But it must be borne in mind that September is still a summer-type month in California and few South Pacific LOWS are to be expected. There are only 14 seasons out of the past 40 years that have LOWS entering south of latitude 43° in September. They are: 1883, 1887, 1888, 1889, 1900, 1901, 1902, 1903, 1904, 1908, 1909, 1910, 1916, 1921. Of the LOWS 4 entered between Cape Blanco and Cape Mendicino. Two of them, those of 1883 and 1889, preceded very wet seasons; the one in 1903 preceded a full average season centrally, but the season was partly dry in the south. This last one is the only season out of the 14 that was dry for southern California. The rest of the seasons preceded by LOWS entering south of Cape Mendocino were all average to wet in southern California.

Considering, however, all LOWS entering south of latitude 43°, 12 out of 14, or 86 per cent, preceded average to wet seasons in southern California, and of such seasons about the same number, though differently distributed, followed in central California. None of these LOWS, on the other hand, preceded very dry seasons, which is a fact well worth considering.

The forecast values of high and low pressure areas of October.—During the summer months of July, August, and September there is very little change in the high-pressure conditions along the coast. There is, almost continuously, a high pressure over the ocean west of Washington, Oregon, and northern California. The high pressure, which in summer is nearly always oceanic later is both the oceanic and the land type. The change begins to come in October, or sometimes not until November; then there is often a radical change from the uniform and rainless oceanic conditions.

The steadiness of summer conditions gives us, therefore, no information of the coming winter conditions, unless, as remarked, a cyclonic area strikes in during September along the southern coast. This occurs only about one year in three, and at irregular intervals.

But as October is a month of important changes in pressure conditions and is sometimes a rainy month, it should give us some intimations of the conditions forming for the ensuing rainy season. This is manifest in two ways: (1) By the mobility or the stagnation of HIGHS over the plateau and the adjacent ocean; (2) by the occurrence of South Pacific LOWS in October.

(1) *The mobility or stagnation of the HIGHS.*—Early in certain seasons there is an accumulation of anticyclonic and therefore dry atmosphere in our central and southern California latitudes, extending well westward over the ocean and eastward to the Rockies. This area of high barometer sometimes remains stagnant over the plateau for a considerable period. If the stagnation increases in November, there is a season of below-the-average rainfall in the making. But if the HIGHS move rapidly across, this indicates that there is no stagnation forming west of the Rockies to prevent storms coming in from the ocean.

Normally in winter, plateau HIGHS move on southward and southeastward. They thus admit of the entrance of the LOWS, which correspondingly become deflected more to the south. But in certain seasons this high pressure does not move normally southward, but remains centered in the plateau region. For some as yet unknown cause in some winters a descending cold dry atmosphere seems to come down directly over the plateau, or over the ocean, or over both areas, and intensifies this already anticyclonic condition.

Sometimes a North Pacific LOW will be deflected southward and begin to disrupt this stagnant Great Basin HIGH, or the oceanic HIGH, but with only temporary success. Not until the HIGH decreases in its own intensity, i. e., not until the barometer falls appreciably in the plateau itself, can any LOW impinge permanently and give rain anywhere near by. Though this continental HIGH may begin in October, the peak in dry seasons is not reached until the end of December and sometimes even in January. The less it is disrupted during this period the more pronounced will be the dry season, especially in southern California.

(2) *The South Pacific* LOWS.—Of an opposite condition to both oceanic and continental HIGHS are the welcome October LOWS.

September on this coast, as previously remarked, is barometrically a month of the summer type. When occasionally a rain does fall, it is only for a day or two, after which the normal summer type of weather returns and continues. October is different, but its character varies considerably in different seasons. It may show a continuation of the average September summer type, it may be of the rainier type, or it may partake of both types. Barometrically it is also different from September. Even if no rain falls, the high pressure over the ocean is changing its position, especially in certain seasons.

I have investigated all the October LOWS for 40 years, up to and including the season of 1921–22. This period has 15 seasons with South Pacific October LOWS, 38 per cent of the whole. Occurrences of both September and October LOWS in the same season are certain to be followed by an average to wet season in *either* central or southern California, without a single exception. There is also a strikingly high percentage of these seasons that are quite wet in *both* central and southern California. It is almost a certainty (better than a 90 per cent probability) that when South Pacific LOWS enter south of Cape Mendocino in either September or October, the ensuing season, especially for southern California, will be average to wet. This high percentage does not hold good for northern California, but it does for central California.

The 15 seasons referred to as having October South Pacific LOWS are: 1883–84, 1889–90, 1890–91, 1894–95, 1896–97, 1900–1901, 1902–3, 1904–5, 1906–7, 1908–9, 1909–10, 1910–11, 1916–7, 1921–22, and the slightly below-average season of 1901–2, which was below average only in southern California. In some instances LOWS are not shown on the maps, but they are inferable from the text; especially does this apply to the so-called secondary LOWS. After reviewing the daily weather charts, I have proceeded on the assumption that when a heavy rain comes in from off the coast and the influence of the primary LOW is not apparent, this rain is caused by a secondary LOW.

The significance of November rains in the South.—When, as far south as Santa Barbara, the average or nearly the average rainfall in November occurs, it appears to be indicative of the free movement of LOWS, and, except in a very few instances, average to wet seasons follow.

The average November rainfall at Santa Barbara is 1.50 inches and the average seasonal rainfall 18.50 inches. We may consider an inch as a fair precipitation for November, and note the kind of season ensuing, with 1 inch and upward of November rains. I have listed every season since 1867, and find there are 23 seasons at Santa Barbara having an inch or more of precipitation in November. These 23 seasons I have tabulated as follows (see Table 2): The first column contains the seasons since 1867 having a rainfall at Santa Barbara for November of 1 inch or more; the second column gives the rainfall at Santa Barbara for the corresponding Novembers; the third column gives the totals of the respective ensuing seasonal rainfall; the fourth column gives in percentage of the average rainfall the corresponding seasonal rainfall for southern California. and the fifth column the same information for Central California.

TABLE 2.—*Relation between November rainfall of 1 inch or more at Santa Barbara and the rainfall of the ensuing season, at Santa Barbara and in southern California*

Season	Santa Barbara November rainfall (inches)	Santa Barbara seasonal rainfall (inches)	Percentage of average seasonal rainfall	
			Southern California [1]	Central California [2]
1867–68	2.30	25.22	150	167
1868–69	1.25	15.77	100	91
1871–72	1.80	15.00	[3] 73	120
1874–75	1.30	18.70	85	82
1875–76	6.53	23.07	125	125
1877–78	1.32	29.51	137	125
1879–80	1.62	25.64	133	120
1885–86	9.84	24.24	145	140
1887–88	1.10	21.71	105	68
1888–89	5.62	21.58	120	100
1889–90	3.20	32.43	175	185
1892–93	4.27	26.97	130	112
1896–97	3.50	18.50	115	98
1899–1900	1.97	12.66	58	106
1900–1901	4.00	15.40	98	107
1901–2	1.16	14.21	72	90
1902–3	4.00	20.74	120	96
1905–6	1.14	22.70	126	128
1908–9	1.84	36.29	124	116
1909–10	2.34	19.62	92	86
1913–14	3.40	31.50	140	130
1918–19	3.64	14.50	80	102
1922–23	1.98	17.00	70	100

[1] These percentages are based on the averages at the following stations: Santa Barbara, Los Angeles, San Bernardino, Santa Monica, Riverside, Redlands, and San Diego, the percentages for the earlier years being based on the fewer stations then available.

[2] These percentages are based on the averages at the following stations: San Francisco, Sacramento, Marysville, and Merced, the percentages prior to 1871–72 being based on San Francisco and Sacramento only.

[3] 1871–72 was a wet season north of Santa Barbara; San Luis Obispo had 27 inches, San Francisco 31 inches. We have but scant records from south of Santa Barbara for these early years. Los Angeles unofficial records give 12 inches, or 78 per cent of normal, but as a whole southern California averaged 73 per cent only.

Reviewing this period of 55 years at Santa Barbara, there were, as observed 23 years of fair November rains; that is, rains of 1 inch or more. The outstanding facts are:

1. That though there were quite a number of dry seasons in southern California during this period, only one of them appears in the list shown in the table, the season of 1899–1900. And this exception, since it had the characteristic plateau high pressure of the drier seasons, can not be said to invalidate the theory of the significance of normal November rains with respect to the ensuing season. In November 1899 the storm that caused the normal monthly rainfall at Santa Barbara was intense enough to affect the southern coast in spite of the plateau high pressure, the rains being very heavy in the north and tapering off rapidly toward the south. Eureka had the extraordinary amount of 15 inches, and San Diego 0.35 inch.

2. Nineteen seasons out of the 23 having normal or over November rainfall had a rainfall of the average amount or more in the ensuing rainy season of southern California.

3. Central California had 22 seasons out of the 23 with seasonal rainfall of average amount or more, certainly a very striking fact.

To sum up inferences based on records of more than half a century, the conclusion is that fair November rains (1 inch or more) as far south as Santa Barbara forecast, for southern California with a probability of 83 per cent and for central California of 96 per cent, that an average to wet season will follow. That is to say, the probability of very dry seasons for southern California following fair November rains at Santa Barbara is 17 per cent, and for central California but 4 per cent. About four-tenths of the seasons of record have been preceded by such November rains. If this ratio to the total number of seasons continues as in the past, it would indicate that in somewhat less than half the years the above probabilities will be applicable. The writer wishes to emphasize here that the high probabilities above given relate not at all to the kind of seasons that have followed Santa Barbara November rains of less than 1 inch. There are several cases of normal or above normal seasonal rains following November rains of less than 1 inch; hence a "dry" November may mean either deficiency or excess to come. But, as shown, the "moderately wet" to "wet" Novembers have been followed in a very high percentage of cases by normal or above normal seasonal rains.

San Diego rains as an indication of the rainfall of the ensuing season.—In reviewing the rainfall records of San Diego my attention was called to the fact that San Diego occasionally has noticeable summer (July, August, and September) rains when no rains occur elsewhere on the coast at the same time, and that these summer rains have no apparent connection with those of Arizona.

The average total rainfall at San Diego for these three months is only 0.23 inch, due to the number of rainless seasons. These months as is well known, are characterized by semipermanent high pressure off the northwestern coast and by summer or heat LOWS over Arizona. The summer rains of San Diego seem to be of different origin from those of the interior; they come mainly from the southwest. They seem to indicate a more than normal intensity of the tropical cyclonic activity over the Pacific Ocean. These storms are sometimes first observed along the Mexican coast as far south as Mazatlan (latitude 22°) or else as coming in directly from the Pacific south of the thirtieth degree of latitude.

The great flood season of 1861–62 in California was preceded by excessively heavy rains early in the season at San Diego, when no rain at all fell north of Los Angeles. In October, 1883, a very heavy rain fell at San Diego in connection with a violent storm that moved northeastward from the Gulf of California (MONTHLY WEATHER REVIEW, October, 1883, p. 223), and the rainfall season of 1883–84 was very wet in both central and southern California. Late in September, 1921, a rain of 1.65 inches fell at San Diego and was hardly felt a little to the north. The storm track map of the month (MONTHLY WEATHER REVIEW, September, 1921), showed that this storm, of the hurricane type, was first observed opposite the Mexican tropical coast near Mazatlan. It then moved in a northwesterly direction and, turning inland near San Diego, took a northeasterly course. It was intense enough to cross the United States and pass out into the Atlantic. In the following December, LOWS of unusual extent appeared off the coast of southern California and gave nearly two weeks of rain. Again in January and February of the same season LOWS entered southern California with correspondingly heavy rains. The September LOW seemed thus a forerunner of them all.

At San Diego in the 72 seasons 1850–51 to 1921–22, there have been 21 summers with rainfall for July, August, and September totaling 0.21 inch or over the average for all summers being 0.24 inch. The rainfall of these 21 summers is given in Table 3, together with the respective ensuing seasons' total rainfall at six stations in southern California for which long records are available. Only the territory west of the mountain ranges is considered, since southeastern California has a desert climate. Now, assuming 0.21 inch to be an "average" summer rainfall at San Diego, the tabulation shows that 19 seasons out of the 21 that had average or more than average summer rains preceded average to

wet seasons in southern California. But the partially dry seasons of 1912–13 should properly be eliminated from this count, because its July and August rains, when traced to their origin with the aid of the Weather Bureau maps, are seen to be a result of the westward extension of interior LOWS, and therefore are rains from LOWS that did not come off the Pacific Ocean. Consequently, when we consider only the appreciable summer rains at San Diego due to LOWS that came in from the Pacific, *there are 19 seasons out of 20 that preceded average to wet seasons in southern California*, indicating a 95 per cent probability of similar occurrences for the future. The only regrettable fact is the infrequency with which these "average" summer rains occur.

TABLE 3.—*San Diego summer rains in relation to the ensuing rainy season in southern California*

Season	San Diego summer rainfall (normal 0.24")	Seasonal rainfall at—					
		Los Angeles (normal 15.62")	Redlands (normal 14.55")	Riverside (normal 10.74")	San Bernardino (normal 16.04")	San Diego (normal 9.70")	Tustin (normal 13.04")
1852–53	0.40					11.03	
1853–54	.21					9.77	
1854–55	1.52					13.56	
1861–62	1.59					15.64	
1863–64	.36					5.14	
1865–66	1.29					12.82	
1867–68	.30					11.23	
1868–69	.56					11.68	
1873–74	1.95				23.81	7.88	
1874–75	.25				13.65	5.73	
1875–76	.60				19.90	10.11	
1880–81	.41	13.13			13.50	9.66	9.49
1890–91	.65	13.36	19.06	12.89	18.08	10.47	14.76
1902–3	.92	19.32	15.82	12.74	17.42	11.76	15.85
1905–6	.66	18.65	16.61	15.14	19.88	14.68	19.00
1906–7	.22	19.30	21.85	16.31	23.17	10.62	19.68
1908–9	.84	19.18	14.47	12.02	17.36	10.23	14.45
1912–13	.40	13.42	7.96	7.16	11.08	5.87	8.11
1916–17	.28	15.26	14.07	9.11	13.79	10.13	10.38
1919–20	.36	12.52	15.82	12.00	19.28	9.00	13.03
1920–21	1.24	19.66	25.50	19.75	27.75	18.65	17.51

In this connection, as with the results from my consideration of Santa Barbara rains, it should be stated that this high probability by no means indicates that we can forecast *in general* the seasonal rainfall from the summer rainfall. If the summer is "dry," it has no significance whatever in relation to the ensuing season's rainfall, for many wet seasons have followed almost rainless summers. But when the average to heavy summer rains do come, then the high probability above shown applies.

On examining the seasons above discussed, I find that nearly all of them had the South Pacific LOWS of September or October. When they have both the LOWS and the rains, the wetness of the coming rainy season is further assured.

DISCUSSION

By A. J. HENRY

The two articles immediately preceding deal with a question of great scientific and economic importance.

Blochman presents statistical evidence of the tendency of the weather to persist for a time in the same sense, an idea that has been discussed for some years in Europe. Von Hann in his Lehrbuch, third edition, refers to it under the caption "Die Erhaltungstendenz der Witterungstypen."[1] Others have alluded to it in connection with seasonal forecasting and only very recently Weise has computed the correlation coefficients between pairs of months, January–February, March–April, etc., for the 165-year temperature record for Leningrad,[2] first for the record as a whole, then for the three 50-year periods and finally for each of the five 30-year periods. The significant result is reached that the coefficients for corresponding pairs of months in some of the 30-year periods differ very materially from each other, whereas in the longer periods the coefficients are fairly uniform as between the several parts of the record.

Doctor McEwen utilizes ocean surface temperatures along the coast of southern California as an index to the pressure over the northeast Pacific and endeavors to pass from ocean pressures to the rains in a limited section of southern California six months later. The rather striking thing about this purely empirical method is that it gives the correct sign of the rainfall departure in eight out of nine cases, although the absolute amounts of rain are not indicated so closely.

Doctor McEwen in attempting to set forth his conception of the physical relations involved in the production of wet and dry years in California, is fully conscious of the difficulty of coordinating the very few facts at hand, and he therefore makes certain basic assumptions, some of which, in the view of the present writer may not be in accord with theory and experience. It is a question, indeed, whether scientific research of the present day is sufficiently well organized and equipped to cope with the truly great problem of seasonal weather forecasting, involving as it does the entire atmosphere of the globe. For more than 50 years meteorologists have been observing and charting the paths of anticyclones and cyclones; yet in all this time they have scarcely passed beyond the observing stage, for very little is yet known of the precise method of origin of these formations and the source of their maintenance as they travel over the face of the globe.

Out of the fifty-odd years of study have come the facts that cyclones with their attendant rain and cloud seemingly prefer to remain over the oceans in winter rather than pass on to the continents; also that their fullest development takes place over the oceans rather than the land.

It is also generally recognized that low surface temperatures over the land in winter, the presence of anticyclonic wind systems and perhaps still other causes, not yet clearly recognized, obstruct the free movement of cyclones especially over the land. These are some of the reasons why cyclones coming from the Pacific tend to incline toward the Gulf of Mexico and to enter the continent below 45° north latitude in some winters and not in others.

The rainfall in California is conditioned upon the pressure distribution over the Pacific to the west and also over the Great Basin and plateau region of western United States. In winter what may be called the North Pacific statistical anticyclone is at a minimum, and coincidently therewith the statistical anticyclone of the Great Basin is at a maximum. While the intensity of the latter by reason of being over the continent can be precisely delimited each winter, its oceanic counterpart is practically unknown.

It seems reasonable to endeavor to connect, as Doctor McEwen has attempted to do, the North Pacific statistical anticyclone with the weather in the United States. The descriptive term "statistical" is used to connote a pressure formation that is based upon the average pressures over a period longer than 24 hours, generally for a month.

[1] Lehrbuch der Meteorologie dritte auflage seite 629. See also Georgii, Walter: Wettervorhersage. Dresden, 1924.

[2] Met. Zeit. 42: 217–225, Wiese W, studien uber die Erhaltungstendenz der mittleren monatlichen Temperaturanomalien.